Improving the Academic Inclusion of a Student with Special Needs at University Bordeaux

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ABSTRACT
Recently, there has been a sharp increase in the number of students with disabilities (SWDs) enrolled in universities. Unfortunately SWDs still struggle to attain the same level of education as non-disabled students. This paper presents a collaborative approach between members of the student support service, researchers and a special needs student in order to improve his access to and participation in university education. We performed a person-technology match and analyzed different existing technologies. Then, we designed and printed a keyguard, keyboard stand and mobile armrest which allowed him to almost double his text entry speed on a computer. We hope that our experience will inspire other universities to better address the needs of students with disabilities.

Author Keywords
Accessibility, students with disabilities, 3D-printing, DIY, text entry.

ACM Classification Keywords
K.4.2 Social Issues: Assistive technologies for persons with disabilities

INTRODUCTION
Until recently, in France as overall Europe, children with disabilities were often sent to specialized schools. However, in the past decades the integration of disabled children in mainstream schools has been promoted. Recent legislation deeply changed the obligations of French universities regarding the enrolment and support of students with disabilities (SWDs). Simply put, this legislation requires French universities to adapt to SWDs, rather than expecting SWDs to adapt to inaccessible universities. As a result, there has been a sharp increase in the number of SWDs enrolled in French universities since 2005. However, SWDs tend to be underrepresented in postgraduate courses and whereas approximately 30% of non-disabled people earn a degree, this figure falls to 6% for people with disabilities. In order to help SWDs compensate for their disabilities, they are often provided with human or technological assistance by university student support services (e.g. the Service "PHASE" at the University of Bordeaux). Many SWDs also benefit from accommodations for their special needs such as extra time and separate rooms when taking exams [5].

We report about a concrete effort to improve access to and participation in universities classes for a motor and speech-disabled student at University Bordeaux. This project was conducted in collaboration between student support services, researchers, and a special needs student using off-the shelf as well as Do-It-Yourself (DIY) technologies.

A COLLABORATIVE DESIGN APPROACH
This project involved three different types of stakeholders: a special needs student (YN), the student support services (service "PHASE", represented here by AM) and three researchers (JJK, AMB, PG). The project was initiated when YN's English language teacher revealed difficulties interacting with and assessing him. From this need then emerged a collaboration between PHASE and researchers in the field of accessibility (both at University Bordeaux) to find ways to help this student. We chose to adopt a user-centered approach, taking into consideration the skills, knowledge and current practices of the members of PHASE as well as YN's needs and wishes. It is especially important to consider users' needs when designing for people with impairments, as a lack of consideration for their needs is one of the reasons for a high Assistive Technology (AT) abandonment rate [13]. Researchers and members of PHASE held several meetings (one per month on average over a period of 6 months). The first two meetings served to identify the issues faced by members of PHASE and to outline several goals to address these issues. The following meetings served to discuss and review the work in progress to make sure that the end users were involved at every step of the project. Researchers also held several meetings (one per week on average) and conducted tests with YN. Discussions during these numerous meetings and encounters allowed us to make the following observations:

1) YN's specific needs most importantly concerned communication with and assessment by teachers. Members of PHASE lack the time and skills to deal with the specificities regarding his personal situation and needs.

2) More and more SWDs will require AT. Members of PHASE tend to learn about available AT as they go along,

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through individual experience. They have little or no training in AT for students.

3) The Univ. of Bordeaux's guidelines take into account the need to increase digital as well as physical accessibility. So far, the latter has been rather well catered for, whereas the former seems to have been somewhat overlooked.

Although we observed an overall need to help PHASE with information regarding AT, the most urgent goal was to identify an efficient, acceptable and affordable solution to improve YN's academic inclusion. Therefore, we focused on this in a first step. To do so, we performed a needs assessment, and then identified available AT that could potentially help YN. We then tested this AT with YN to achieve an optimal person/technology match.

IDENTIFYING A SOLUTION FOR YN

YN is over 60 years old and has a severe motor and speech impairment resulting from an accident. Besides, he is not a native French speaker. Consequently, YN experiences functional difficulties in an academic context, as regards to communication and assessment in particular. YN carries a "low-tech communication device" in the form of an A4 sheet of paper, on which the 26 letters of the alphabet, a question mark, numbers from 1 to 9 and short answers such as "Yes", "No" and "I don't know" have been written with a marker pen (Fig. 1). As YN is unable to speak, he points to the letters on this keyboard to ask and answer questions and to make requests. However, YN's arm movements are very slow and imprecise, which makes communication difficult both for him and his interlocutors. Moreover, the arm movements required to communicate using this paper keyboard are very tiring and can sometimes even be painful. YN is also able to use a standard computer keyboard to interact with a computer, but once again his movements are slow and imprecise so that his typing speed is very low. Furthermore, the use of a conventional computer mouse is difficult because of the precision of movement required to operate this device effectively. This student is also able to write by hand with a pen and paper but his writing speed is even slower than when using a computer keyboard. Thus, it is currently all but impossible for this student to fulfil the requirements expected of a

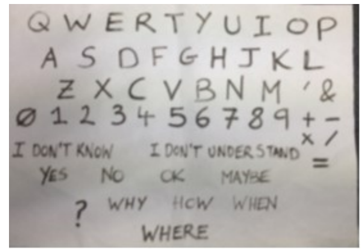

Figure1. YN's low tech communication device

university student.

The majority of SWDs who arrive at university level have completed their high school education only months before. The specificity of YN's case is that he graduated as a healthy young adult who had no need for AT, and only decided to return to university after the onset of his disabling condition, some 30 years later. He is also dealing with this situation in a country and a cultural environment which are not his own. Moreover, due to his age, he has developed his own habits and is somehow reluctant to using Assistive Technology, such as augmentative and alternative communication (AAC) devices [19]. Thus, on the one hand he has no experience in terms of AT for academic purposes, and on the other hand teachers, university personnel and his peers are finding it difficult to interact with and assess him.

Needs Assessment

The first step in attempting to identify some form of AT for YN was to assess his needs in an academic context. We based our needs assessment on observation, video footage and conversations with YN, as well as with a teacher and members of PHASE. It was agreed that communication and assessment by teachers were the activities that ought to be focused on. We hypothesized that if computer interaction efficiency (i.e. typing speed and pointing accuracy in particular) could be improved, then communication and assessment could potentially be facilitated.

Matching the AT to the individual

Positive outcomes of AT use can only be expected if it is correctly matched to the person with disabilities (PWD) [15,17]. To produce an optimal person/technology match,

Figure 2: AT selected to be tested by YN. Figure 2a: A computer screen fitted with the Tobii EyeX eye-tracker and displaying the Optikey typing Interface. Figure 2b: The keyboard and DIY keyguard

the needs and expectations of the PWD must be taken into account. However, there is a large array of factors that influence whether a PWD will adopt, use or abandon an AT device. When performing the person/technology match, one must take into account aspects of the environments in which the technology will be used, the needs, preferences and expectations of the user, and the functions and features of the technology [17]. There are many barriers that can prevent AT devices from being adopted by PWDs who could potentially benefit from them, such as cost and possible stigmatization to name but two [6,12]. Thus, PWDs must play an active part in the AT selection process [16], which can help to reinforce their self-determination [20]. Increasing self-determination is a priority for university student services, since PWDs are often less self-determined than their non-disabled peers and self-determination is associated with quality of life [21].

Selected AT devices

Various forms of AAC devices exist, including manual signs, voice output communication devices, and picture-based systems [14]. As mentioned above, our goal was to provide YN with access to technology which best corresponded to his habits. With the aim of increasing typing speed and pointing accuracy to facilitate interaction with a computer, several potentially suitable AT devices allowing for YN's abilities were identified. These AT devices were then presented to YN, who participated in identifying the potentially efficient, affordable and acceptable solutions. The device that ranked first on the list of selected AT was an eye-tracking device (Tobii EyeX; Fig. 2a), which could potentially replace both the computer mouse and keyboard if combined with an on-screen visual keyboard such as that provided by the open source software OptiKey (https://github.com/OptiKey/OptiKey).

The second choice for text entry was a standard keyboard fitted with a keyguard (i.e. a rigid keyboard cover which prevents involuntary key presses for people with imprecise motor control; Fig. 2b). Indeed, observation and viewing of video footage revealed that one of the factors that reduced YN's typing speed was the number of accidental keypresses, especially when reaching for keys at the top of the keyboard (including "backspace" and "delete", thus creating more errors when trying to make corrections). This is in part due to the way YN holds his hand while typing (Fig. 3a). Commercial keyguards range in price from 100 to 700 euros, thus to reduce the expenses, a keyguard was modelled with OnShape (www.onshape.com) and 3D printed to fit the keyboards used at the university. We provide this 3D model on Thingiverse (https://www.thingiverse.com/thing:
2256376, Fig. 3a and b). It allows a keyguard to be printed for a fraction of the price of commercially available ones. The use of 3D printing and DIY technologies is gaining popularity in many fields, particularly because it facilitates the design and production of inexpensive, easily modifiable prototypes. The fields of physical and occupational therapy as well as AT are also beginning to realize the potential of using 3D printing to create personalized AT devices or making existing devices accessible [3,7,8,10,11].

As alternative pointing devices we selected a touchpad (Acer™ Laptop computer touchpad) and a trackball (Kensington Slimblade™). Indeed, one of the issues when using a standard mouse was YN's difficulty in maintaining the position of the mouse (and thus of the on-screen pointer) while clicking. We aimed to avoid this problem by using a touchpad or a trackball, since with these devices clicking cannot affect the position of the pointer.

Measuring the benefits of selected AT devices

To evaluate whether potentially suitable devices were indeed beneficial, YN performed several tests using the selected AT. These tests were not conducted as part of a research project, but as a practical way to determine which AT, if any, would best meet YN's academic needs. As such, the priority was not to use scientifically validated evaluation methods (e.g. those described in [1,9,18]), but quick assessment tools that are nevertheless capable of providing objective measures of AT efficiency. We used the online application Aimbooster (www.aimbooster.com) to evaluate pointing accuracy, and an online typing speed test (https://10fastfingers.com/typing-test/french) to evaluate text entry efficiency. It soon became apparent that eye-tracking did not hold as much promise as we had

Figure 3a: YN's particular hand position while typing that sometimes causes accidental key presses and made the use of a keyguard slightly uncomfortable. Figure 3b: the DIY keyguard on its stands and the mobile armrest.

expected (Fig. 4 & 5). In particular, we assume that this was due to YN's left eye sometimes clos involuntarily, and the difficulty he experiences in maintaining his head relatively still. This is a problem when using eye-tracking systems which are not attached to the body (i.e. integrated in glasses) because head movements after calibration reduce the accuracy of the tracking system [4].

Improvements were made to the keyguard based on observation and discussions with YN. Indeed, YN types with his middle finger, which remains fully extended while typing (Fig. 3a). The keyguard makes keys difficult to access when typing with a fully extended finger. Thus, in an iterative design process a tilted keyboard stand was designed and 3D-printed to facilitate key-pressing. However, this again created further difficulties since to reach keys at the top of the keyboard, YN had to lift his hand from the desktop, thus increasing fatigue and imprecision. In order to try to remediate this, we prototyped a 3D-printed mobile armrest that slides over the surface of the table on a felt base, offering support at all times (Fig. 3b). Using the 3D printed keyguard, keyboard stand and mobile armrest (Fig. 3b), typing speed was almost doubled compared to the standard keyboard (Fig. 4). This is a considerable improvement, but YN is still only able to type at maximum speeds of 40 characters per minute (CPM), whereas it is generally considered that 200 CPM is the average typing speed for non-disabled individuals, and average hand-writing speed is approximately 70 CPM [2].

Using the trackball and touchpad, pointing accuracy was increased compared to the standard computer mouse (Fig. 5). YN found the trackball more satisfying to use than the touchpad, in particular since the ball of the trackball can be manipulated with the entire hand.

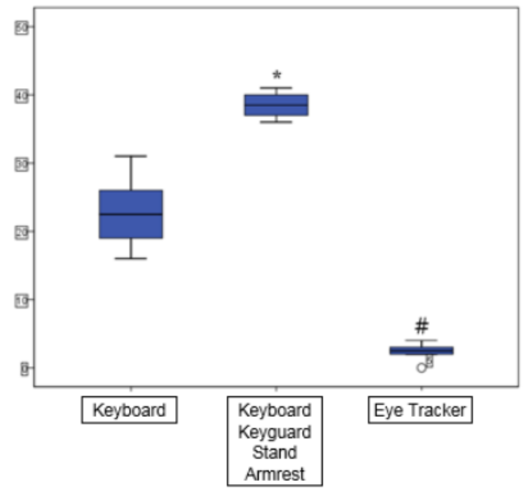

Figure 4: YN's typing speed in CPM with the various AT devices. * significantly faster than the keyboard alone; #significantly slower than the keyboard alone.

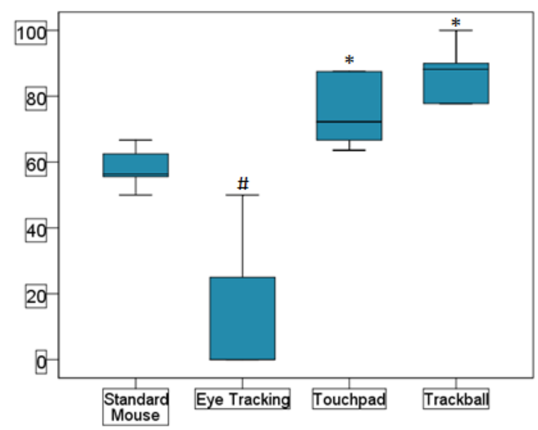

Figure 5: YN's accuracy (%) with the different AT devices. *significantly more accurate than the standard mouse; #significantly less accurate than the standard mouse.

DISCUSSION

Another way of improving the efficiency of computer interaction is to reduce the number of clicks necessary to perform a task (by creating desktop links for instance) and to increase the size of on-screen elements. Furthermore, an array of settings can be changed to adjust the sensitivity of the mouse (or pointing device) and the time delay granted between the two clicks of a double click. YN was unaware of these options, and we suspect that simple adjustments such as these have the potential to facilitate computer interaction for many SWDs. Similar results might have been achieved through the work of an occupational therapist, however, as mentioned above, student support services handle the needs of various students with various disabilities without having access to such support.

CONCLUSION

In this experience report we describe our collaboration between researchers and members of the student support services PHASE at the University of Bordeaux to help a student with special needs to participate in his studies and communicate with teachers. We add to the literature commending the use of 3D-printing for producing prototypical or indeed fully functional AT. We designed and printed a keyguard, keyboard stand and mobile armrest which allowed the motor and speech impaired student to almost double his text entry speed on a computer. We also highlight challenges encountered by members of the student support services as numbers of SWDs increase at the university. The work presented in this paper is the result of a novel collaboration between researchers in accessibility, the university's student support services and the special needs student. We believe that more of these collaborations are needed and hope that our experience will inspire other universities to better address the needs of students with disabilities.

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